BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

(12) **PATENT**
(19) **AUSTRALIAN PATENT OFFICE**

(11) Application No. **AU 199656182 B2**
(10) Patent No. **703290**

(54) Title
Installation and process for measuring rolling parameters by means of artificial vision on wheels of railway vehicles

(51)[6] International Patent Classification(s)
B61K 009/12 **G01B 015/04**
G01B 011/04

(21) Application No: **199656182**

(22) Application Date: **1996.06.25**

(30) Priority Data

(31) Number	(32) Date	(33) Country
9501305	**1995.06.29**	**ES**

(43) Publication Date : **1997.01.09**
(43) Publication Journal Date : **1997.01.09**
(44) Accepted Journal Date : **1999.03.25**

(71) Applicant(s)
Patentes Talgo, S.A.

(72) Inventor(s)
Angel Luis Sanchez Revuelta; Carlos Javier Gomez Gomez

(74) Agent/Attorney
SPRUSON and FERGUSON,GPO Box 3898,SYDNEY NSW 2001

(56) Related Art
US 4798964
US 4798963
US 4749870

AU9656182

(12) PATENT ABSTRACT (11) Document No. AU-A-56182/96
(19) AUSTRALIAN PATENT OFFICE

(54) Title
INSTALLATION AND PROCESS FOR MEASURING ROLLING PARAMETERS BY MEANS OF ARTIFICIAL VISION ON WHEELS OF RAILWAY VEHICLES

International Patent Classification(s)
(51)[6] **B61K 009/12** **G01B 011/04** **G01B 015/04**

(21) Application No. : **56182/96** (22) Application Date : **25.06.96**

(30) Priority Data

(31) Number	(32) Date	(33) Country
9501305	**29.06.95**	**ES SPAIN**

(43) Publication Date : **09.01.97**

(71) Applicant(s)
PATENTES TALGO, S.A.

(72) Inventor(s)
ANGEL LUIS SANCHEZ REVUELTA; CARLOS JAVIER GOMEZ GOMEZ

(74) Attorney or Agent
SPRUSON & FERGUSON , GPO Box 3898, SYDNEY NSW 2001

(57) Claim

1. Installation for measuring rolling parameters by means of artificial vision on wheels mounted on railway vehicles which are moving at manoeuvring speed, in which, amongst other parameters, the thickness and the height of the flange of the wheel, the qR factor, the diameter of the wheel and the distance between internal faces are measured, and in which a reproduction with parameters of the profile of the wheel is generated, characterized in that it comprises a steel slab (2) on which the wheel (1) which it is desired to measure runs, a guard rail (3) which interacts with said steel slab to prevent derailment, a wheel-position sensor (9) which emits a signal when the wheel is in a suitable position for measurement, a laser generator (5) which, upon being activated by said signal, throws a planar beam of laser light onto the wheel, a camera (6) with lens and filter which captures the image generated by said planar beam of light, a controller (10) for illuminating and capturing the image which synchronizes the acquisition of the image through the wheel-position sensor (9), high-r solution artificial-vision electronic equipment (11) which analyses the image captured by said camera and which sends the measurements obtained to a central control computer (8) where they are processed and visualized on a monitor (13).

S & F Ref: 343029

AUSTRALIA

PATENTS ACT 1990

COMPLETE SPECIFICATION

FOR A STANDARD PATENT

ORIGINAL

Name and Address of Applicant: Patentes Talgo, S.A.
Montalban 14
28014 Madrid
SPAIN

Actual Inventor(s): Angel Luis Sanchez Revuelta and Carlos Javier Gomez Gomez

Address for Service: Spruson & Ferguson, Patent Attorneys
Level 33 St Martins Tower, 31 Market Street
Sydney, New South Wales, 2000, Australia

Invention Title: Installation and Process for Measuring Rolling Parameters by Means of Artificial Vision on Wheels of Railway Vehicles

The following statement is a full description of this invention, including the best method of performing it known to me/us:-

INSTALLATION AND PROCESS FOR MEASURING ROLLING PARAMETERS BY MEANS OF ARTIFICIAL VISION ON WHEELS OF RAILWAY VEHICLES

FIELD OF THE INVENTION

The present invention refers to the field of the high-precision measurement of the rolling parameters on wheels mounted on railway vehicles which are moving at manoeuvring speed. Of these parameters, the most important include the following: thickness and height of the flange of the wheel, qR factor, diameter of the wheel and distance between internal faces. Similarly, according to the invention, a reproduction, including parameters, of the profile of the wheel is generated, making it possible to compare it with other standard profiles or to make any other type of measurement.

The invention is embodied in an installation for measuring the said parameters and in a corresponding operating process.

The installation of this invention may be constructed on any type of track where the vehicles move at manoeuvring speed, it being possible for it to be located inside the sheds or outside them. The measurements made on the vehicles which are moving over these tracks are processed and sent to rolling-stock maintenance centres so that operations for rectifying any deficiencies detected in the condition of the wheels can be carried out there.

BACKGROUND OF THE INVENTION

The prior art has already dealt with the contact-free measuring of parameters of surface structures. Thus, Patent ES-A-499 366 describes a track-borne movable measuring vehicle which carries an emitter and a receiver of laser rays as well as means for indicating and, if appropriate, storing the measurement data for the surface studied; Patent ES-A-2 054 398 relates to a track-borne vehicle for m asuring the geometric parameters of a railway track using a proximeter and optical distance gauges; also, Patent EP-A-0 461 119 covers a device for

interferometric measurement of surface structures which includes at least two laser sources and which is used to measure the phase difference in pairs of laser particles at set measurement points on the surface investigated. All these measurement systems apply to fixed surface structures, such as tracks, tunnel openings and defiles, but, unlike the present invention, they do not make it possible to measure parameters of moving objects, such as the wheels of a vehicle. Similarly, Patent EP-A-0 467 984 protects a plant for detecting the wheel profile of trains with the aid of an illuminating unit, a scanning unit, a measuring unit and a data processor. However, the technological principles on which said plant is based differ from those used to develop this invention.

Therefore, the problem posed by the invention has hitherto not been dealt with or solved in the manner and under the conditions advocated by it, which means that the installation and the process set forth in this specification are novel and offer an inventive step vis-à-vis the known state of the art.

SUMMARY OF THE INVENTION

In basic terms, the invention consists in the generation of a planar beam of laser light which falls upon the wheel to be measured in its lower part by virtue of a rail which is specially designed to act as support for the wheel of the train on the flange or in its outermost part, depending on whether the diameter or the profile of the wheel is being measured. In this way, it is possible to take images of the projection of the circumference of the wheel, formed by the laser beam, in the zone with the lowest instantaneous speed of movement and with reference to the support rail. Clearer, less distorted images are thus obtained at greater speed.

Accordingly, in one aspect of the present invention there is provided installation for measuring rolling parameters by means of artificial vision of each wheel mounted on railway vehicles which are moving at manoeuvring speed, in which, the parameters include the thickness and the height of the flange of the wheel, the angle of the active face (qR factor), the diameter of the wheel and the distance between internal faces of opposite wheels, and in which a reproduction with parameters of the profile of the wheel is generated, said installation comprising a steel slab on which the wheel whose parameters to be measured runs, a guard rail which interacts with said steel slab to prevent derailment of said wheel, a wheel-position sensor which emits a signal when the wheel is in a suitable position for measurement, a laser generator which, upon being activated by said signal, projects a planar beam of laser light onto the wheel, a camera with lens and filter which captures the image generated by said planar beam of light, a controller for illuminating and capturing the image which synchronizes the acquisition of the image through the wheel-position sensor, high-resolution artificial-vision electronic equipment which analyses the image captured by said camera and which sends the measurements obtained to a central control computer where the measurements are processed and displayed on a monitor.

According to another aspect of the present invention there is provided a process for measuring parameters of wheels mounted on moving railway vehicles comprising:

advancing the wheels of a moving railway vehicle on steel slabs which support the wheels on outer portions of the wheels,

producing a signal from a wheel-position sensor when an associated wheel travels past said sensor,

activating a laser generator by said signal to produce a planar beam of laser light directed onto said associated wheel,

producing, by a camera, an image of the associated wheel illuminated by said beam of laser light,

synchronizing the production of said image of the associated wheel by its associated said sensor,

supplying the said image to artificial-vision electronic analysis equipment,

supplying an output of said artificial-vision electronic analysis equipment to a computer in which the desired parameters are obtained and displayed on a monitor, and

wherein the measurement of the profile of the wheel and of the distance between inner faces of opposite wheels, and the measurement of the diameter of the wheel are achieved with measurement components which form part of a single unit.

According to yet another aspect of the present invention there is provided a process for measuring parameters of wheels mounted on moving railway vehicles comprising:

advancing the wheels of a moving railway vehicle on steel slabs which support the wheels on outer portions of the wheels,

producing a signal from a wheel-position sensor when an associated wheel travels past said sensor,

activating a laser generator by said signal to produce a planar beam of laser light directed onto said associated wheel,

producing, by a camera, an image of the associated wheel illuminated by said beam of laser light,

synchronizing the production of said image of the associated wheel by its associated sensor,

supplying the said image to artificial-vision electronic analysis equipment,

supplying an output of said artificial-vision electronic analysis equipment to a computer in which the desired parameters are obtained and displayed on a monitor, and

wherein the measurement of the profile of the wheel and of the distance between inner faces of opposite wheels and the measurement of the diameter of the wheel are achieved with measurement components which form part of two autonomous units capable of functioning independently of each other.

BRIEF DESCRIPTION OF THE DRAWINGS

A more detailed description of the invention is now given, with reference to the appended drawings, in which an installation embodied according to the invention is diagrammatically illustrated.

Figure 1 shows the installation of the invention applied to the measurement of the profile of a wheel; this figure has been broken down into two parts, the right-hand part of which shows a view of the wheel taken through its rolling wheel rim, whilst the left-hand part shows a view of the wheel taken through one of its faces,

Figure 2 shows the installation of the invention applied to the measurement of the diameter of a wheel, and

Figure 3 shows a sketch of the complete measuring installation according to the invention.

DETAILED DESCRIPTION OF THE INVENTION

With reference, firstly, to Figure 1 of the drawings, it is pointed out that, for measuring the profile of a wheel (the same measurement on the opposite wheel is carried out at the same time), the installation of the invention comprises a specially designed rolling support or steel slab 2 on which the outermost part of the wheel 1 which it is desired to measure is caused to roll and which has a guard rail 3 which prevents derailment. Therefore, the rolling zone which it is desired to analyse remains free, this free zone being equal to at least 75 mm for a wheel-rim width 135. On one side of the steel slab 2 is a wheel-position sensor 9 which, when the wheel passes, sends a signal to a laser-beam generator 5 which is then activated and throws out a planar beam of laser light onto the wheel. With the aid of a mirror 7 for interior illumination (or with the aid of another laser generator), this beam generates the shaded profile 4. The image of this profile is captured by a camera 6

equipped with a lens and filter and is sent, to be analysed, to high-resolution artificial-vision lectronic equipment 11, illustrated in Figure 3. The position of the profile 4 with respect to the stationary parts 2 and 3 makes it possible to obtain the distance between internal faces DCI by computing the values for both wheels.

The installation of the invention which is shown in Figure 2 of the drawings, prepared for measuring the diameter of a wheel, differs, in basic terms, from the installation shown in Figure 1 insofar as the image is taken perpendicularly. In the installation of Figure 2, the wheel 1 runs while resting via its flange and guided by means of the steel slab 2 and the guard rail 3. As in Figure 1, the position sensor 9 emits a signal as the wheel passes and thus activates a laser generator 5 which throws out a planar beam of laser light onto the wheel, a line 12 then being generated on the latter. The image of this line is captured with the camera 6 and analysed by the artificial-vision electronic equipment 11.

The measurement installation of the invention is shown in its entirety in the sketch in Figure 3. The rolling steel slabs 2 serve as support for the cameras 6 and the laser generators 5. A controller 10 for illuminating and capturing the image serves to synchronize the acquisition of the images by means of the position sensors 9. These images are analysed by the vision equipment items 11 which send the measurements and parameters of the profile of the wheel, as well as the measurement of its diameter, to the central control computer 8 where said data are processed to generate the measurement reports for the vehicles, the result being visualized on the monitor 13.

A control cabinet 14 for housing the controller 10 and the artificial-vision equipment items 11, as well as other components of the system. [sic]

In the sketch in Figure 3, the part indicated by MD is prepared for measuring the diam ter of the wheels, whilst the part marked with MP is intended for measuring

the profile and the distance between internal faces of the wheels.

The operating process of the installation according to the invention may be inferred from the preceding description of the figures in the drawings and consists, in basic terms, in that a position-detection system (position sensor 9) activates, for each wheel of the vehicle which is passing, the acquisition of the corresponding image by means of the cameras 6 which are equipped with a filter having the same frequency as the wavelength of the laser produced by the generator 5, thus eliminating the influence of ambient light. The image picked up by the cameras is analysed and corrected geometrically in real time by the high-resolution vision equipment 11, thus making it possible to obtain a high level of precision in the measurements. The invention also makes it possible for acceptable passing speeds to be achieved on vehicles with a wheel base of 1800 mm.

As may be ascertained from the preceding description, the installation consists of two distinct parts, the first of which consists of the equipment for measuring the profile of the wheel, whilst the second is formed by the equipment for measuring the diameter of said wheel. These two parts may form a single installation or, alternatively, may operate independently of each other.

The preceding description of the invention has been made with reference to what constitutes the currently preferred illustrative embodiment thereof. However, as experts in the field will understand, some modifications of form and detail may be made in the installation described and illustrated, as in the component arrangement, without thereby departing from the scope of the invention. Therefore, the intention is that the scope of the invention should be limited solely and exclusively by the contents of the appended claims.

The claims defining the invention are as follows:

1. Installation for measuring rolling parameters by means of artificial vision of each wheel mounted on railway vehicles which are moving at manoeuvring speed, in which, the parameters include the thickness and the height of the flange of the wheel, the angle of the active face (qR factor), the diameter of the wheel and the distance between internal faces of opposite wheels, and in which a reproduction with parameters of the profile of the wheel is generated, said installation comprising a steel slab on which the wheel whose parameters are to be measured runs, a guard rail which interacts with said steel slab to prevent derailment of said wheel, a wheel-position sensor which emits a signal when the wheel is in a suitable position for measurement, a laser generator which, upon being activated by said signal, projects a planar beam of laser light onto the wheel, a camera with lens and filter which captures the image generated by said planar beam of light, a controller for illuminating and capturing the image which synchronizes the acquisition of the image through the wheel-position sensor, high-resolution artificial-vision electronic equipment which analyses the image captured by said camera and which sends the measurements obtained to a central control computer where the measurements are processed and displayed on a monitor.

2. Installation according to claim 1, wherein the image generated by the planar beam of light consists of the profile of the wheel and is obtained with the aid of an interior illumination mirror, or a second laser generator, which interacts with the first said laser generator.

3. Installation according to claim 1, wherein the image generated by the planar beam of light consists of a line on the wheel which symbolizes the diameter thereof.

4. Installation according to any one of claims 1 to 3, wherein the equipment for measuring the profile of the wheel and the equipment for measuring the diameter thereof are incorporated inside the same unit.

5. Installation according to any one of claims 1 to 3, wherein the equipment for measuring the profile of the wheel and the equipment for measuring the diameter thereof are autonomous and capable of functioning independently of each other.

6. Installation according to claim 1, wherein the railway vehicle has a second wheel opposite the first said wheel and said installation further comprises, for said second wheel, a corresponding second guard rail, a corresponding second steel slab, a corresponding second sensor, a corresponding second laser generator and a corresponding second camera which captures an image of the second wheel generated by a planar beam of light produced by said second laser generator, said image of the second wheel being sent, to corresponding electronic equipment connected to said central control computer in which the distance between opposite faces of the first and second wheels is determined and supplied to said monitor.

7. Installation according to claim 1, wherein only an outer portion of said wheel rests on said slab so that a major remaining portion of the wheel, including an inner flange on said wheel, is exposed to said laser beam and said image produced by said camera is a profile of said major portion.

8. Installation according to claim 7, comprising means for laser beam illuminating an inner face of said wheel at said flange.

9. Installation according to claim 1, wherein the image of the profile of the wheel and the image for obtaining the diameter of the wheel are respectively produced at longitudinally spaced locations along said steel slab.

10. Installation according to claim 1, wherein said wheel includes a flange and, for measuring the wheel diameter, said flange rides on said steel slab.

11. A process for measuring parameters of wheels mounted on moving railway vehicles comprising:

advancing the wheels of a moving railway vehicle on steel slabs which support the wheels on outer portions of the wheels,

producing a signal from a wheel-position sensor when an associated wheel travels past said sensor,

activating a laser generator by said signal to produce a planar beam of laser light directed onto said associated wheel,

producing, by a camera, an image of the associated wheel illuminated by said beam of laser light,

synchronizing the production of said image of the associated wheel by its associated said sensor,

supplying the said image to artificial-vision electronic analysis equipment,

supplying an output of said artificial-vision electronic analysis equipment to a computer in which the desired parameters are obtained and displayed on a monitor, and

wherein the measurement of the profile of the wheel and of the distance between inner faces of opposite wheels, and the measurement of the diameter of the wheel are achieved with measurement components which form part of a single unit.

12. A method according to claim 11, wherein for measuring the diameter of the wheel, the flange of the wheel travels on the steel slab and the laser generator produces an image in the form of a line on the circumference of the wheel which line is representative of the diameter of the wheel.

13. A method according to claim 11, comprising supporting only an outer portion of said wheel on said slab so that a major remaining portion of the wheel including an inner flange on the wheel is exposed to said laser beam and the image produced by the camera is a profile of said major portion including said flange.

14. A method according to claim 13, comprising illuminating an inner surface of said flange as part of said profile.

15. A process for measuring parameters of wheels mounted on moving railway vehicles comprising:

advancing the wheels of a moving railway vehicle on steel slabs which support the wheels on outer portions of the wheels,

producing a signal from a wheel-position sensor when an associated wheel travels past said sensor,

activating a laser generator by said signal to produce a planar beam of laser light directed onto said associated wheel,

producing, by a camera, an image of the associated wheel illuminated by said beam of laser light,

synchronizing the production of said image of the associated wheel by its associated sensor,

supplying the said image to artificial-vision electronic analysis equipment,

supplying an output of said artificial-vision electronic analysis equipment to a computer in which the desired parameters are obtained and displayed on a monitor, and

wherein the measurement of the profile of the wheel and of the distance between inner faces of opposite wheels and the measurement of the diameter of the wheel are achieved with measurement components which form part of two autonomous units capable of functioning independently of each other.

16. A method according to claim 15, wherein for measuring the diameter of the wheel, the flange of the wheel travels on the steel slab and the laser generator produces an image in the form of a line on the circumference of the wheel which line is representative of the diameter of the wheel.

17. A method according to claim 15, comprising supporting only an outer portion of said wheel on said slab so that a major remaining portion of the wheel including an inner flange on the wheel is exposed to said laser beam and the image produced by the camera is a profile of said major portion including said flange.

18. A method according to claim 17, comprising illuminating an inner surface of said wheel as part of said profile.

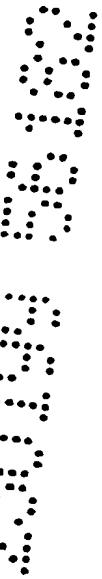
19. Installation for measuring rolling parameters by means of artificial vision, substantially as described herein with reference to the accompanying drawings.

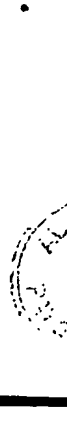
DATED this Eighteenth Day of January 1999

Patentes Talgo, S.A.

Patent Attorneys for the Applicant

SPRUSON & FERGUSON





Installation and Process for Measuring Rolling Parameters by Means of Artificial Vision on Wheels of Railway Vehicles

ABSTRACT

Installation and process for measuring rolling parameters by means of artificial vision on wheels of railway vehicles. The installation comprises a rolling steel slab (2) with its guard rail, a wheel-position sensor (9), a laser generator (5), a camera (6), a controller (10) for illuminating and capturing the image, artificial-vision electronic equipment (11), a control computer (8) and a monitor (13). An interior illumination mirror interacts with the laser generator to obtain the profile of the wheel. The process consists in causing the wheel to run on the steel slab, activating the position sensor, throwing out a beam of laser light onto the wheel and generating an image corresponding to its profile or to its diameter, capturing this image and sending it to the analysis equipment, and transmitting the results of the analysis to the computer for it to process them and visualize them on the monitor.

(Figure 3)

56182/96

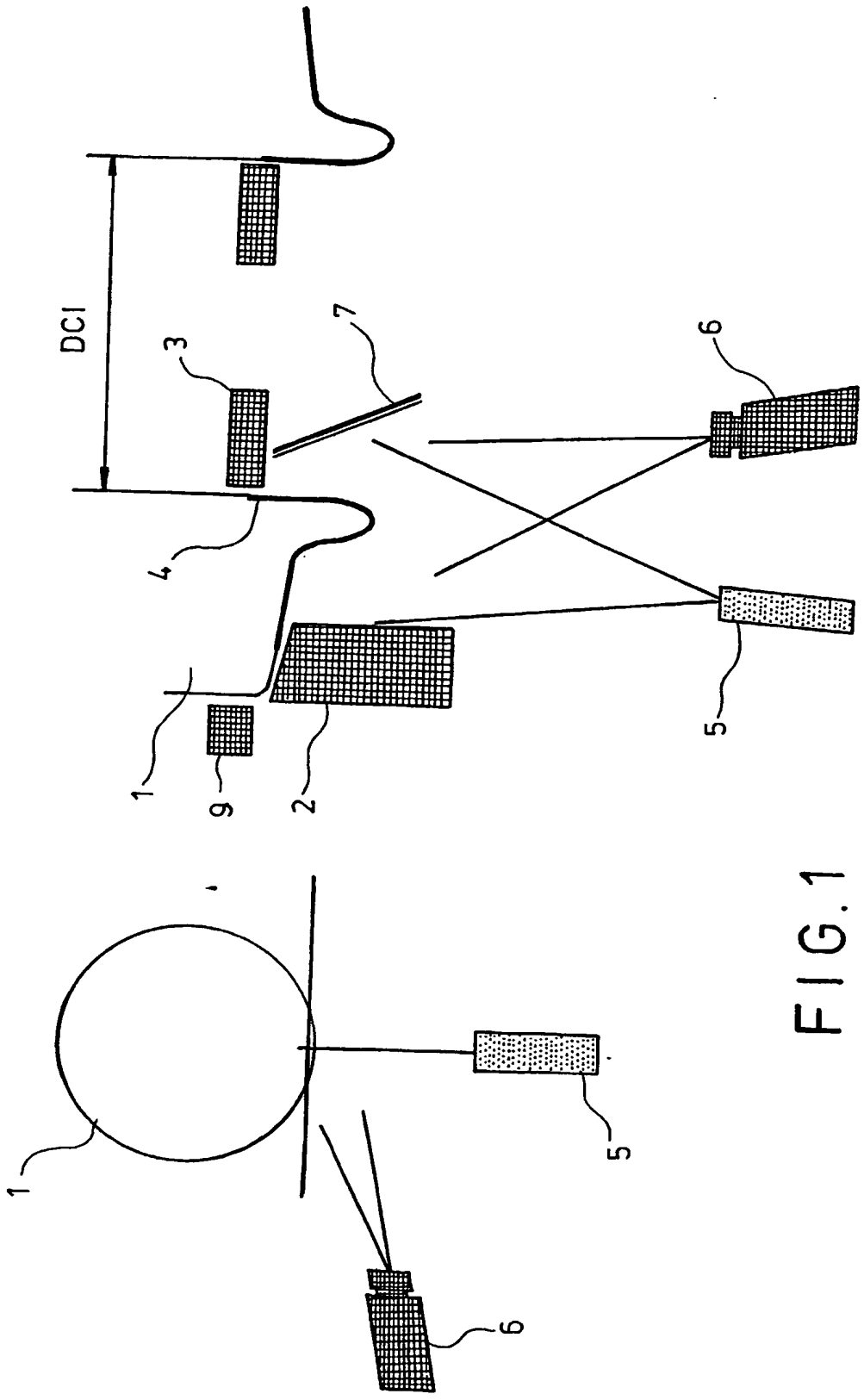


FIG. 1

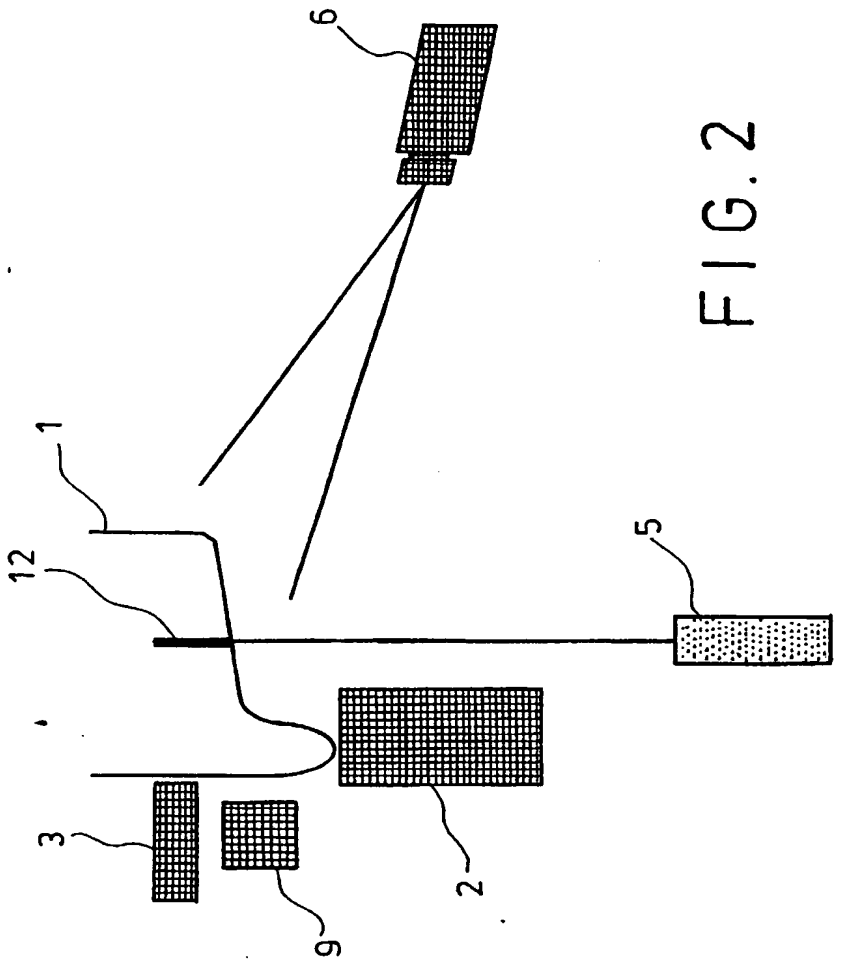


FIG. 2

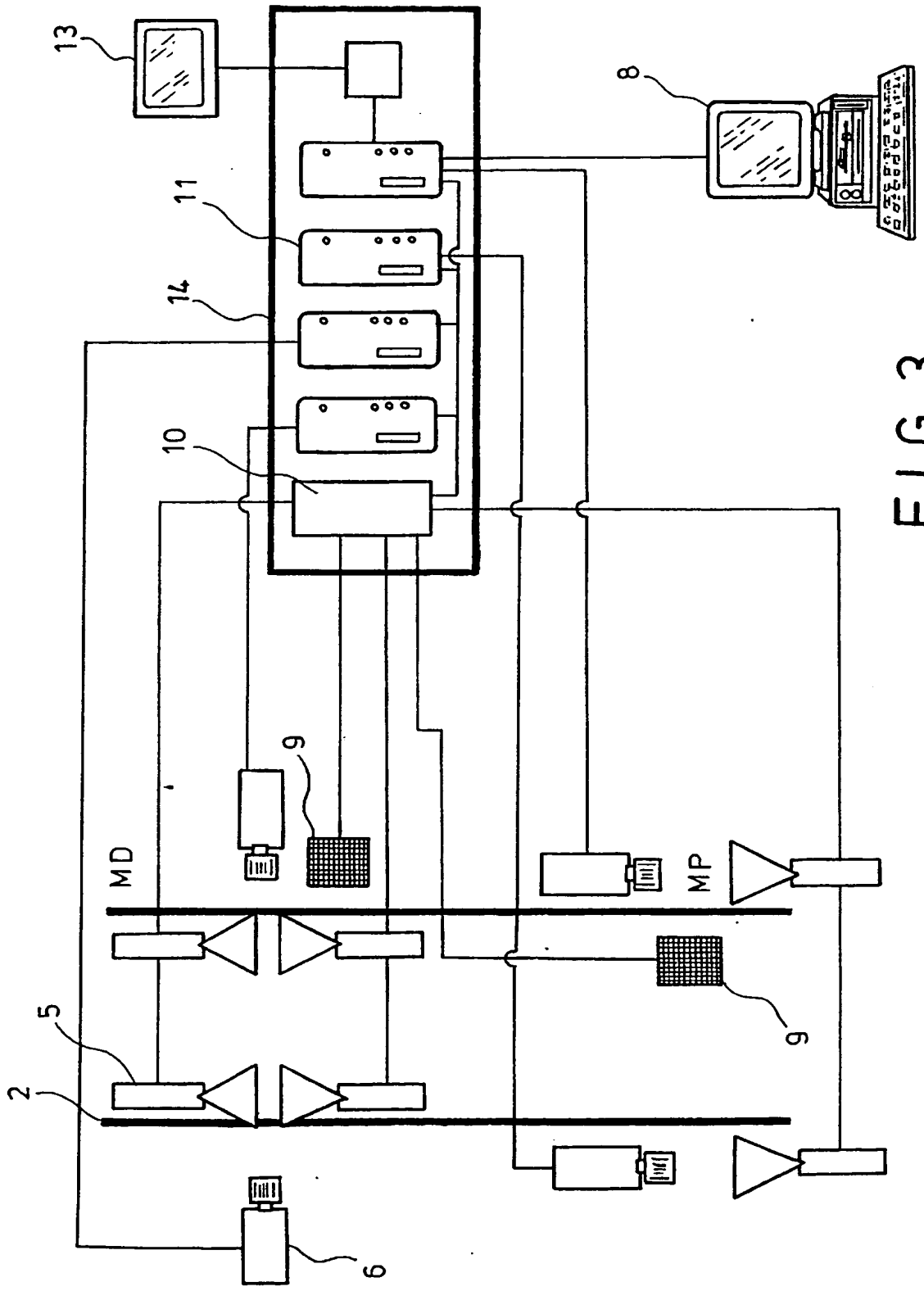


FIG.3